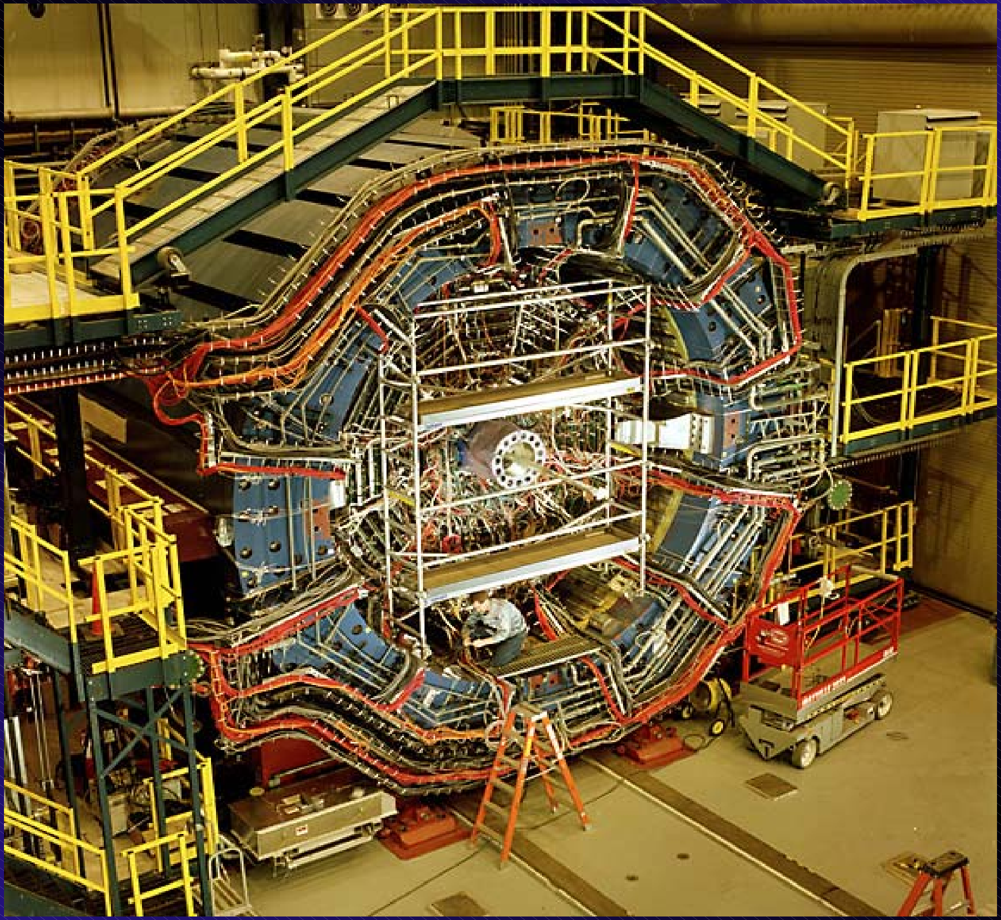
STAR Multi-Year Beam Use Proposal



Tim Hallman

Brookhaven National Laboratory

Program Advisory Committee Meeting
September 29-30, 2003

BROOKHAVEN NATIONAL LABORATORY

Office of Science
U.S. DEPARTMENT OF ENERGY

The STAR Collaboration: 49 Institutions, ~ 500 People

U.S. Labs:

Argonne, Lawrence Berkeley, and Brookhaven National Labs

U.S. Universities:

UC Berkeley, UC Davis, UCLA, **Caltech**, Carnegie Mellon, Creighton, Indiana, Kent State, MIT, MSU, CCNY, Ohio State, Penn State, Purdue, Rice, Texas A&M, UT Austin, Washington, Wayne State, Valparaiso, Yale

Brazil:

Universidade de Sao Paolo

China:

IHEP - Beijing, IPP - Wuhan, USTC, Tsinghua, SINR, IMP Lanzhou

Croatia:

Zagreb University

Czech Republic:

Institute of Nuclear Physics

England:

University of Birmingham

France:

Institut de Recherches Subatomiques Strasbourg, SUBATECH - Nantes

Germany:

Max Planck Institute – Munich
University of Frankfurt

India:

Bhubaneswar, Jammu, IIT-Mumbai, Panjab, Rajasthan, VECC

Netherlands:

NIKHEF

Poland:

Warsaw University of Technology

Russia:

MEPHI – Moscow, LPP/LHE JINR – Dubna, IHEP - Protvino

STAR Run III "Actuals":

Table I

Energy (GeV)	Trigger	System	Events or Integrated Lum Acquired	Goal
$\sqrt{s_{NN}} = 200$	Min Bias	dAu	38.2M	70M
$\sqrt{s_{NN}} = 200$	High p_T	dAu	2.6 nb^{-1}(R) 5.1 nb^{-1}(D)	25 nb^{-1} (D)
$\sqrt{s} = 200$	Min Bias	pp	6 - 8 M	
$\sqrt{s} = 200$	FPD+ (Trans. Pol)	pp	391 nb^{-1}; P ~ 30%	1000 nb^{-1}; P ~ 35%
$\sqrt{s} = 200$	EMC, High Tower	pp	373 nb^{-1}; P ~ 30%	3000 nb^{-1}; P ~ 35%

With the above data set, all STAR scientific and technical goals for Run III were substantially met.

For the ion program:

Measurement of high p_t ("calibration") spectra and leading particle correlations in d + Au, and pp for comparison with AuAu; first results on shadowing and Cronin effect ✓

Measurement of comparison data for soft physics observables in d+Au ✓

Commissioning of EMC high pt trigger ✓

Engineering runs for the endcap electromagnetic calorimeter, the silicon strip detector, and the MRPC TOF Barrel Tray prototype ✓

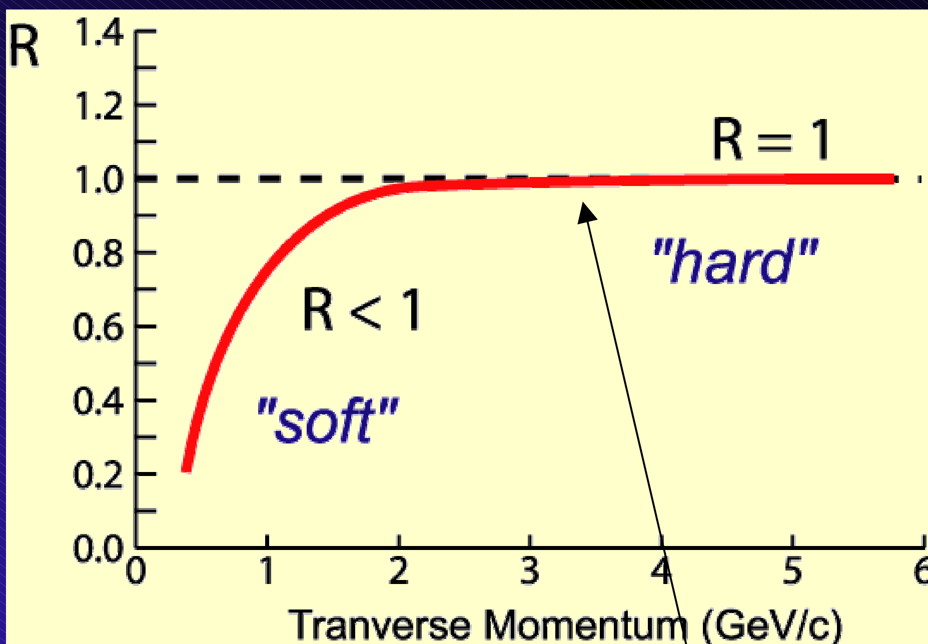
A key probe, new at RHIC: hard scattering of quarks and gluons

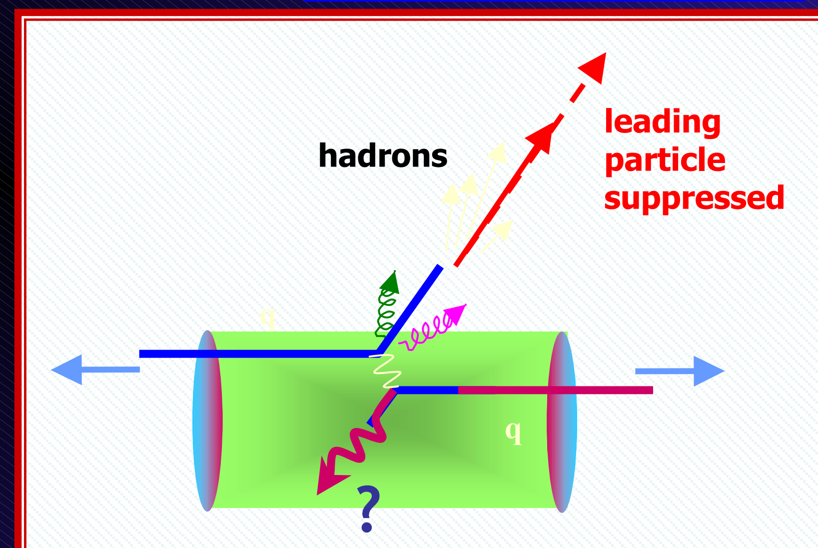
Nuclear Modification Factor:

$$R_{AA}(p_T) = \frac{d^2N^{AA}/dp_T d\eta}{T_{AA} d^2\sigma^{NN}/dp_T d\eta}$$

Nucleus-nucleus yield

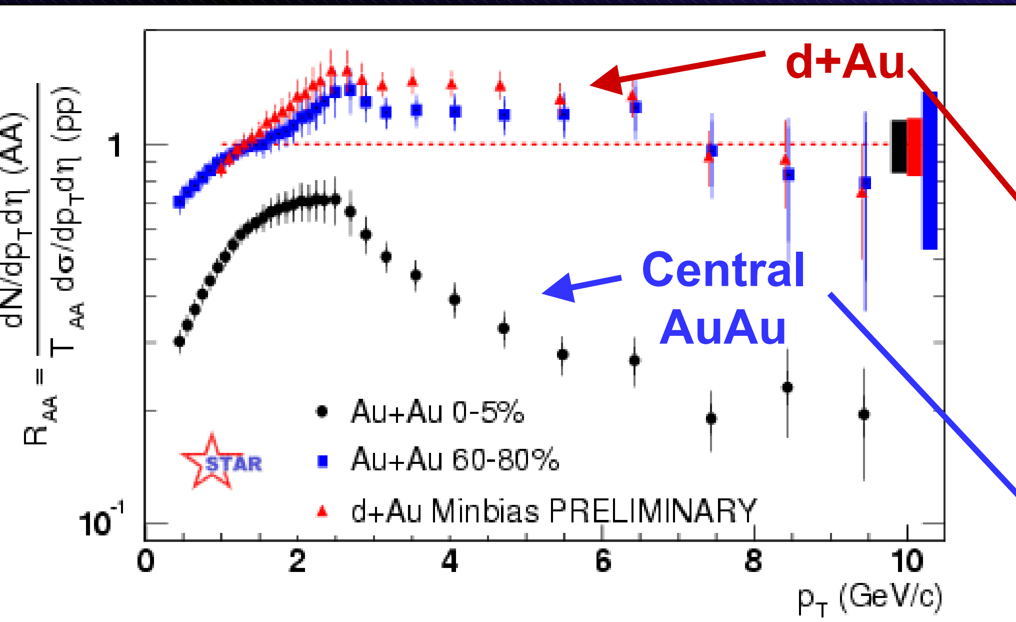
$\langle N_{binary}\rangle/\sigma_{inel}^{p+p}$





If R = 1 here, nothing "new" going on

The d+Au "control" experiment has been performed!

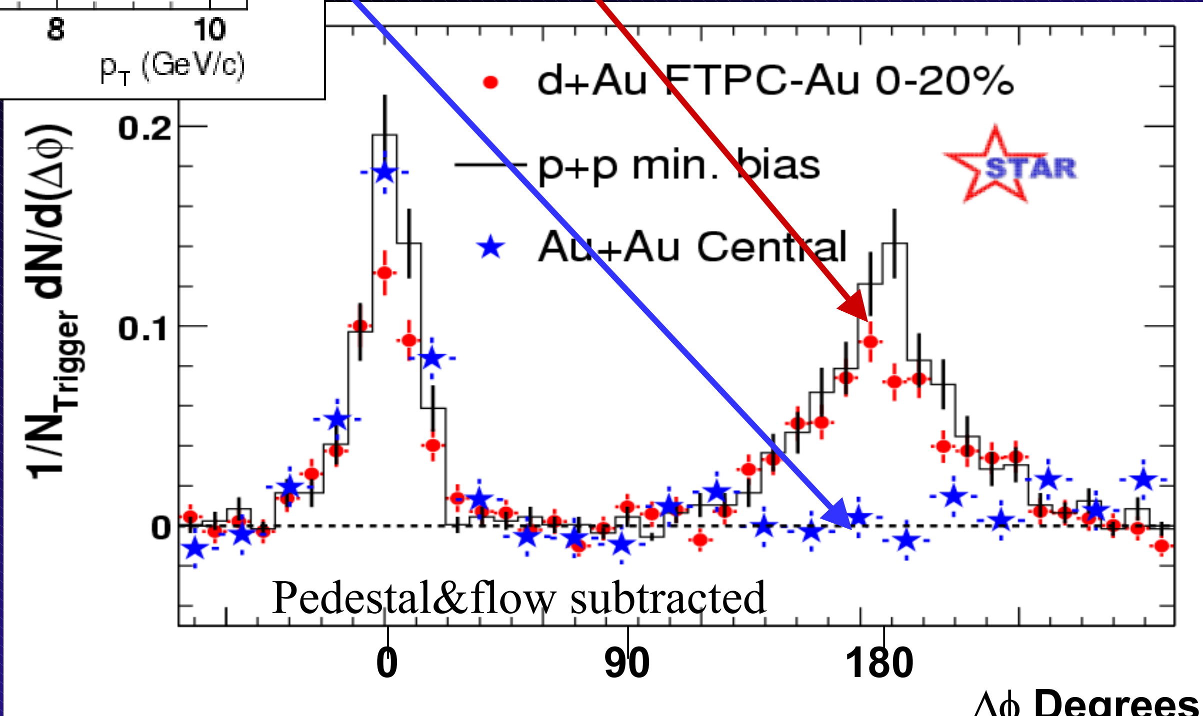


Run II AuAu results at full energy show strong suppression !

d+Au "control" data needed to distinguish between different interpretations

Results show:
Observed suppression due to nature of (new) produced matter !

<u>not</u> initial state effects



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Conclusions About Matter at RHIC:

Is there a phase with bulk properties which are Partonic ?

- The data on high pt suppression and correlations support the conclusion that we have produced a medium that:
  - is dense; (pQCD theory $\rightarrow$ many times cold nuclear matter density)
  - is dissipative (very strongly interacting)
- We need to show that:
  - dissipation and collective behavior occur at the partonic stage
  - the system is deconfined and thermalized
  - a transition occurs: can we turn the effects off ?
- We need:
  - extended AuAu run needed to address several important probes that need large data sets (e.g., p_T dependence of suppression; J/ψ, Υ, open charm, heavy baryon / meson flow); also, species and energy scans to map the evolution of key observables.
  - more guidance from theory (!) particularly on what to expect from hadronic scenarios

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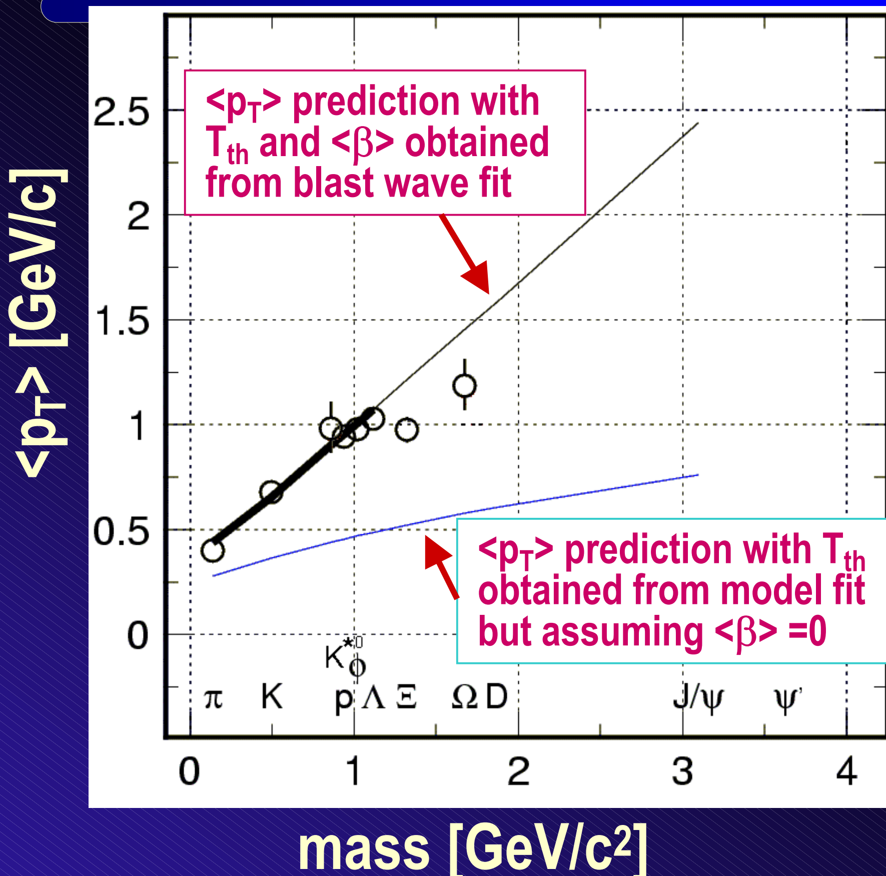
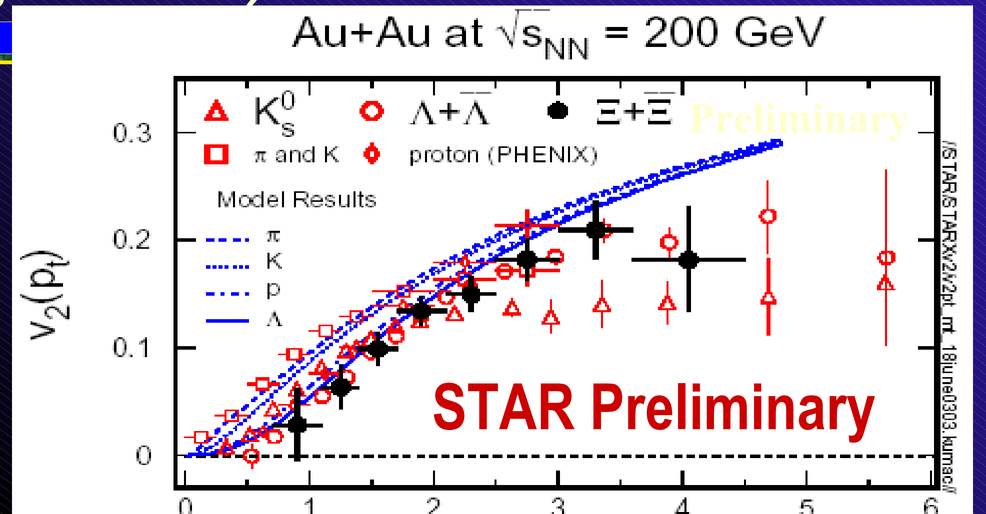
Using the "best barometer" at RHIC to study pressure at early times: new data on the systematics of v_2; $\Xi + \overline{\Xi}$ v_2 from min-bias data

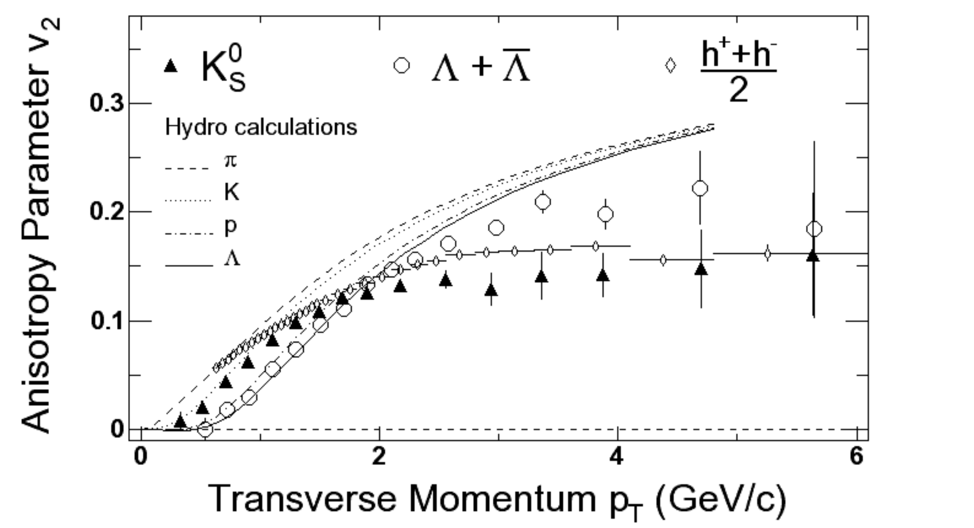


Questions on interpretation remain:

- Origin of meson/baryon difference
- Earlier decoupling for heavy baryons?
- Difference in feed-down?
- Situation in simpler systems (pp, pA)?

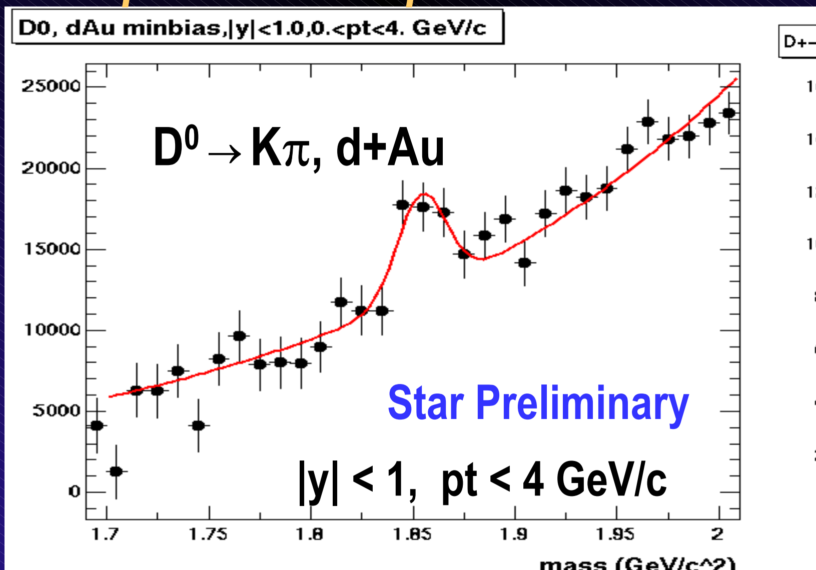


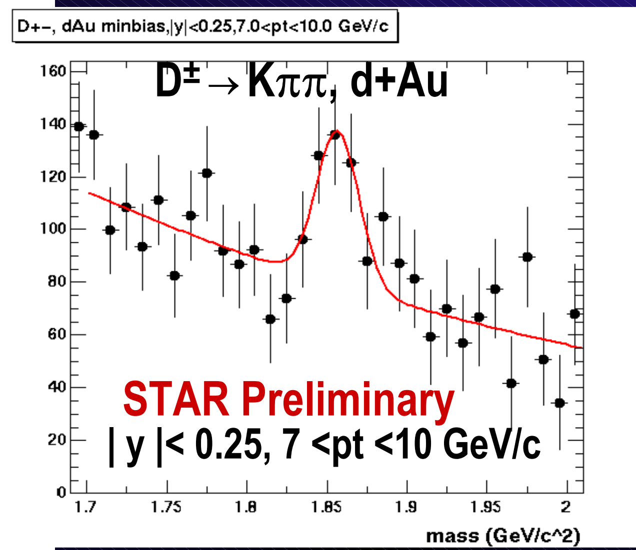
- $\Xi + \overline{\Xi}$ show sizeable elliptic flow!; follow hydro behavior at low p_T; saturate at $v_2 \sim 20\%$ at $p_\perp \sim 3.0$ GeV; Ξ $v_2(p_\perp)$ follows Λ evolution



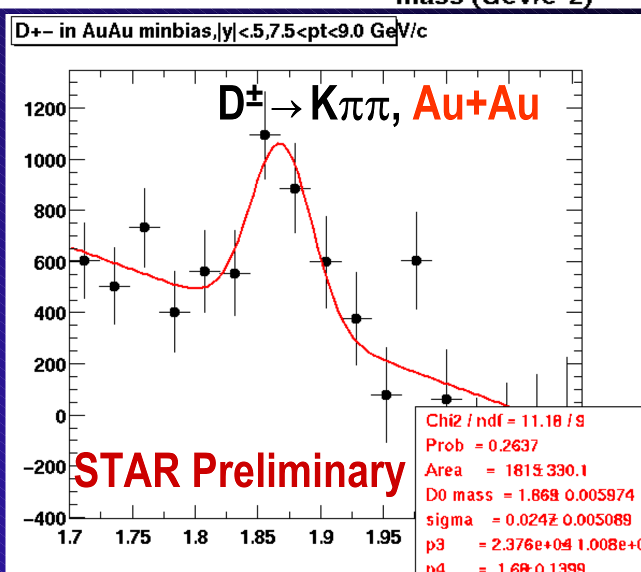
Pressing the search with heavy flavor: first direct observation at RHIC of open charm in d+Au and min-bias Au+Au collisions

Open charm: a probe of initial conditions, and possible equilibration at early times





A.Andronic,
P.Braun-Munzinger,
K.Redlich,
J.Stachel
(nucl-th/0209035)



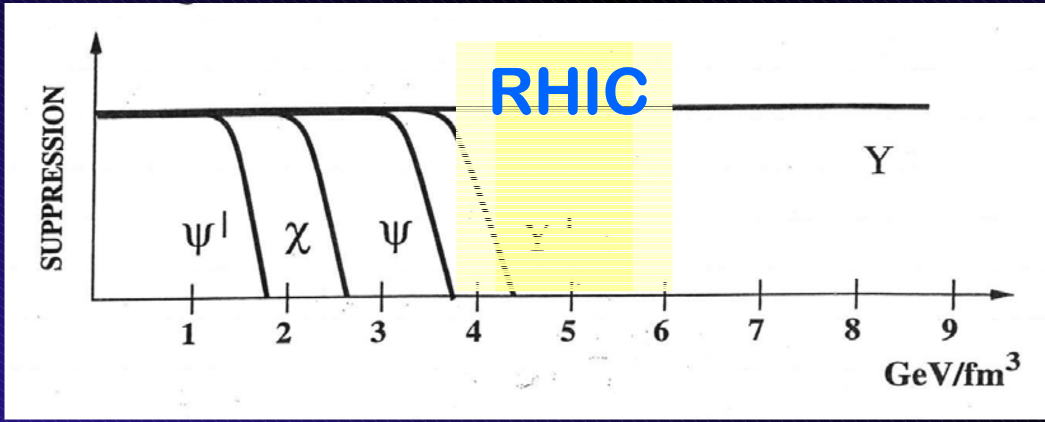
Do c quarks thermalize? If yes, ratio of charm hadrons yield changes from p-p to Au-Au ; D_s^+ most sensitive.

	Pythia p-p 200 GeV	Au-Au Thermal*
D^+/D^0	0.33	0.455
D_s^+/D^0	0.20	0.393
Λ_c^+/D^0	0.14	0.173
$J/\Psi/D^0$	0.0003	0.013

Opening a Window in STAR on Onium

First look in STAR at the onium states (J/ψ, Upsilon, and excited states) to measure the thermodynamics of deconfinement through varying dissociation temperatures

To deeply probe the plasma through studies of (Debye) screening length $\lambda \sim 1/gT$

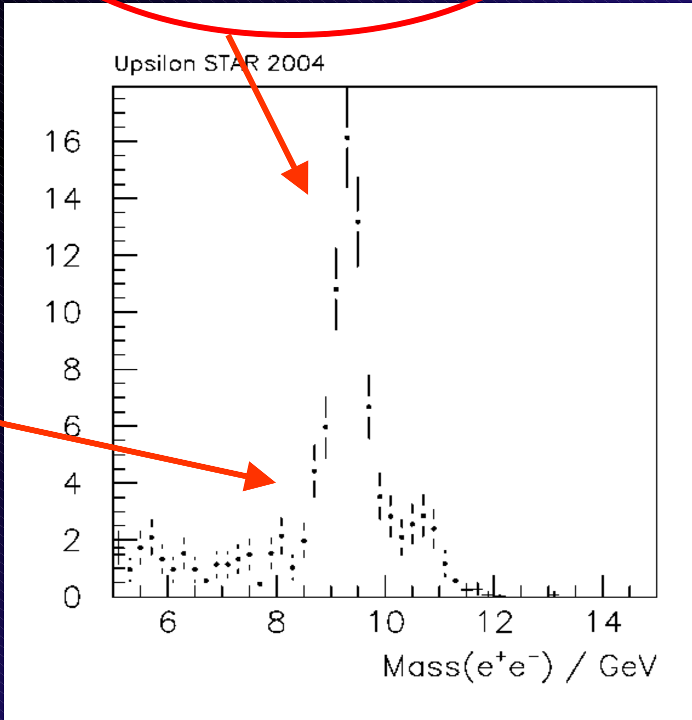


- Study vs. p_T
- Study vs. centrality
- Study in lighter systems
- Study vs a control (the Υ)

- **Upsilon rate ~ 10^{-3} J/Ψ**

Yield in 10 weeks of AuAu running at 32 μb^{-1} /week will be a start

To fully utilize this probe requires high luminosity RHIC running



STAR Beam Use Proposal for Run IV (2003-2004)

Run IV: Jet Quenching and High p_T Hadrons, Partonic Collectivity, Open Charm, Charmonium and Bottomomium; Possible Study of v_2 and High p_T Hadron Production at Lower Energy; First measurement of ΔG

Table II: 27 Week Scenario

Beams	Au + Au	p p
Weeks	5 + 14	5*
$\sqrt{s_{NN}}$	200**	200

(** Based on performance, 2 weeks at $\sqrt{s_{NN}}$ = 63 GeV may be requested)
(* With adequate machine performance, 3 more weeks for physics data taking are requested)

Core goals that drive heavy ion luminosity and uptime requirements:

- ~ 30 million central events useful for D meson spectra
- high pt triggered π° spectra out to 15 GeV/c
- > 50 million min-bias events for Ω v_2
- ~ 5-10k J/ψ and first measurement of the Upsilon in central collisions

The STAR Beam Use Request for Run IV (2003-2004):

Other goals which will also be achieved if the above are realized are:

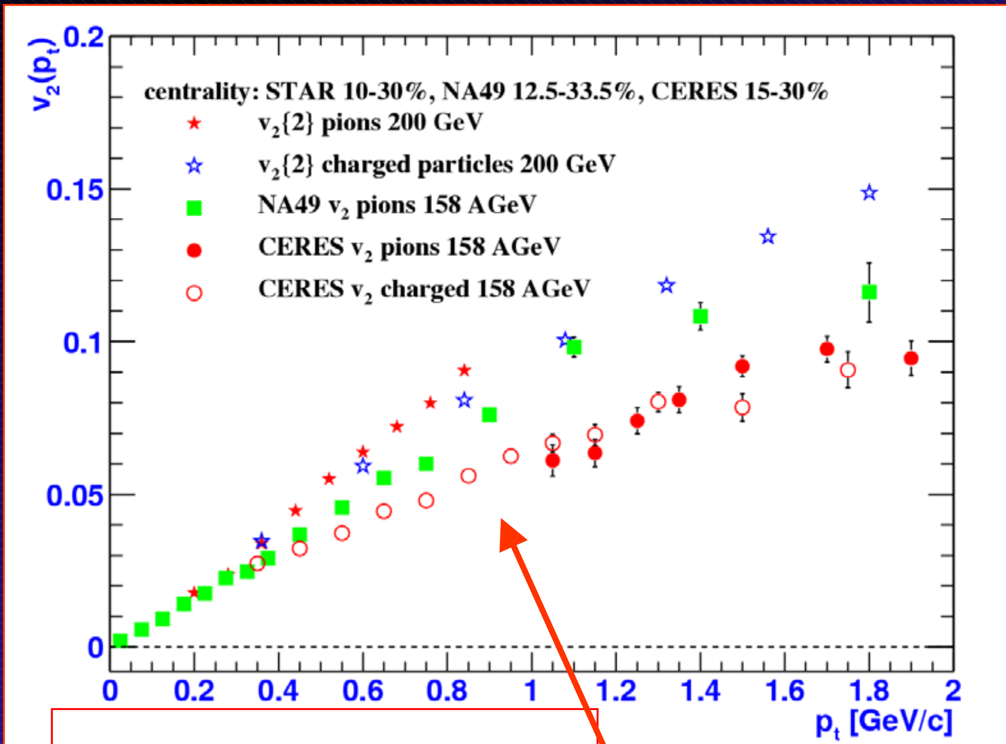
- Detailed study of the centrality and p_t dependence of the Ω and Ξ , (Λ(1520), Σ^*, and Ξ (1520)
- Extension of the pt range for R_{cp} and v_2 studies of resonances and strange/rare particles.
- High statistics samples for event-by-event studies of fluctuations and correlations
- High statistics sample for non-identical particle correlations with respect to the reaction plane; π,K, Baryon HBT with respect to the reaction plane, non-identical hyperon HBT
- High statistics sample for extending UPC measures

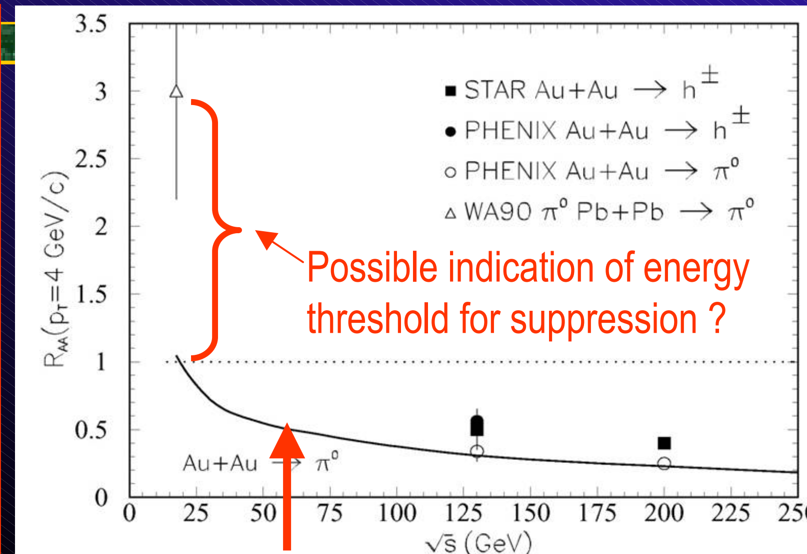
For the physics that drives the BUR, the requirements are:

Goal	Hours/week	$\sqrt{s_{NN}}$	Dead Time	Weeks	Min L_0
30M (50M) Central	45	200	50%	6(10)	12 μb^{-1} /week
30M (50M) Central	45	200	100%	3.7 (6.2)	10 μb^{-1} /week
50M Min-Bias	45	200	50%	6.8	2 μb^{-1} /week
50M Min-Bias	45	200	100%	3.4	1.8 μb^{-1} /week
π° to $p_T \sim$ 15 GeV/c	45	200	50%	6 (10)	33 (20) μb^{-1} /week
4σ Υ signal	45	200	50%	10	32 μb^{-1} /week
$h^\pm$ to $p_T \sim$ 8 GeV/c	45	63	100%	1	1.8 μb^{-1} /week

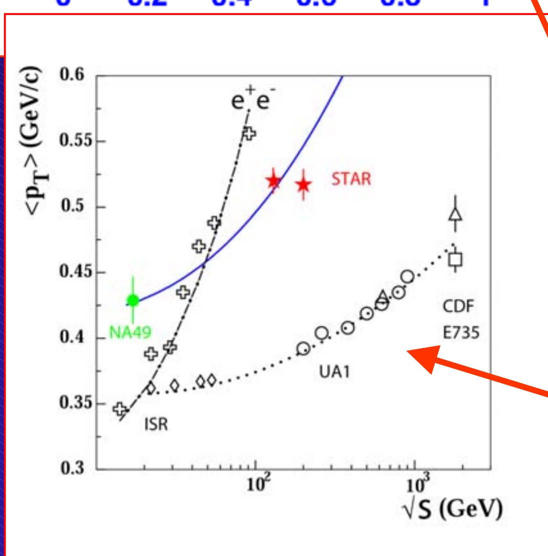
Absolutely Crucial for Success: DAQ100 upgrade (in progress); 45 hours/ week of data acquisition (< one 8 hour shift / day); EMC high p_T triggering

STAR Beam Use Proposal: Request for Lower Energy Point

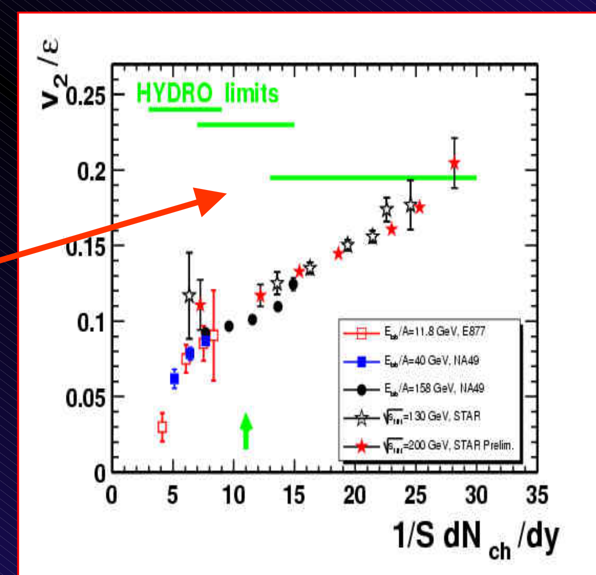




X. N. Wang, nucl-th/0307036



How do we understand v_2 at RHIC vs the SPS and saturation at RHIC of the hydro limit ?



What role does $\langle p_T \rangle$ play ?

Possible Lower Energy ($\sqrt{s_{NN}}$ = 63 GeV) Point in Run IV

If STAR's core full energy heavy ion physics goals can be completed within 12 weeks, STAR proposes to reduce the beam energy to $\sqrt{s_{NN}}$ = 63 GeV

There are Two Goals for a short run at $\sqrt{s_{NN}}$ = 63 GeV

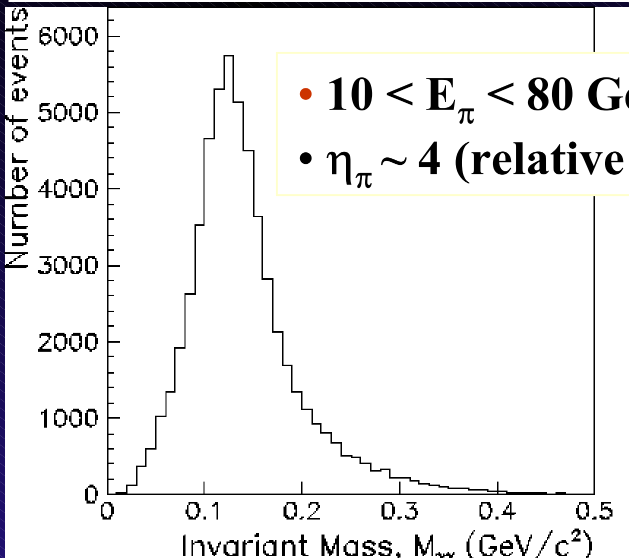
In a run of ~1-2 week duration (45 hours) at a luminosity of > 1.8 μb^{-1} /week STAR can make an important survey measurement that will allow exploration of $h^{\pm}$ suppression out to ~ 6-8 GeV/c, possibly getting a first indication if a threshold in energy exists for this phenomena. This run may be very important in helping to guide beam use for Run V.

The second goal will be better to get a better understanding of the significance of v_2 at RHIC energy and in particular the influence of $\langle p_T \rangle$ on the scaling of v_2 versus $\sqrt{s_{NN}}$

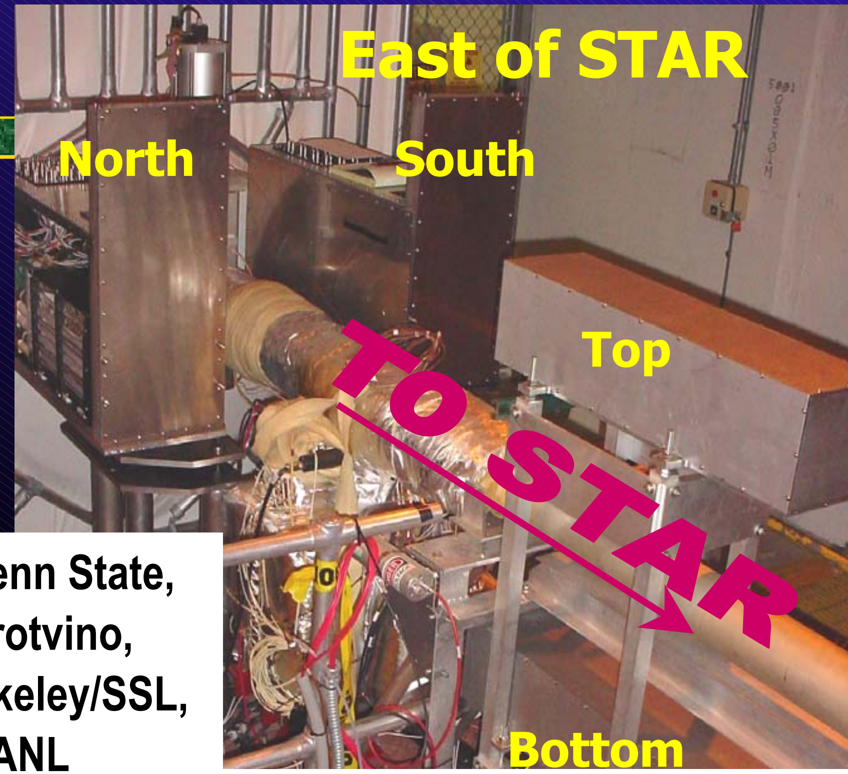
This short run could have a big payoff for the program and be essential for guiding beam use in Run V

The STAR Forward Pion Detector

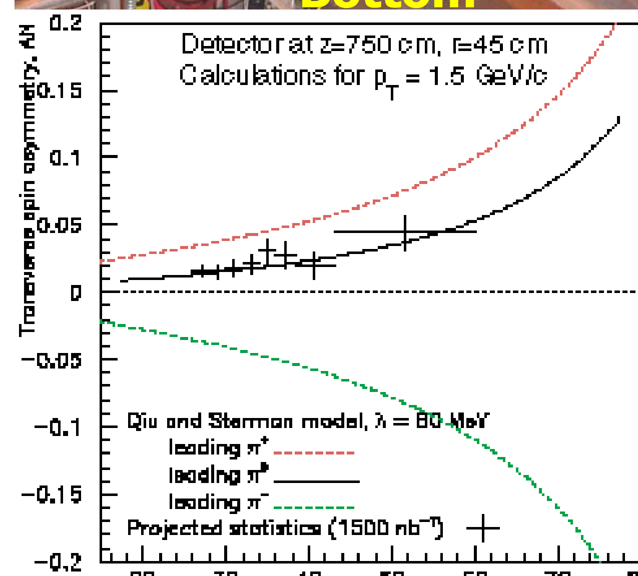
d+Au → π^0+X, $\sqrt{s_{NN}}$ = 200 GeV



- $10 < E_\pi < 80$ GeV
- $\eta_\pi \sim 4$ (relative to d)



BNL, Penn State, IHEP-Protvino, UC Berkeley/SSL, UCLA, ANL

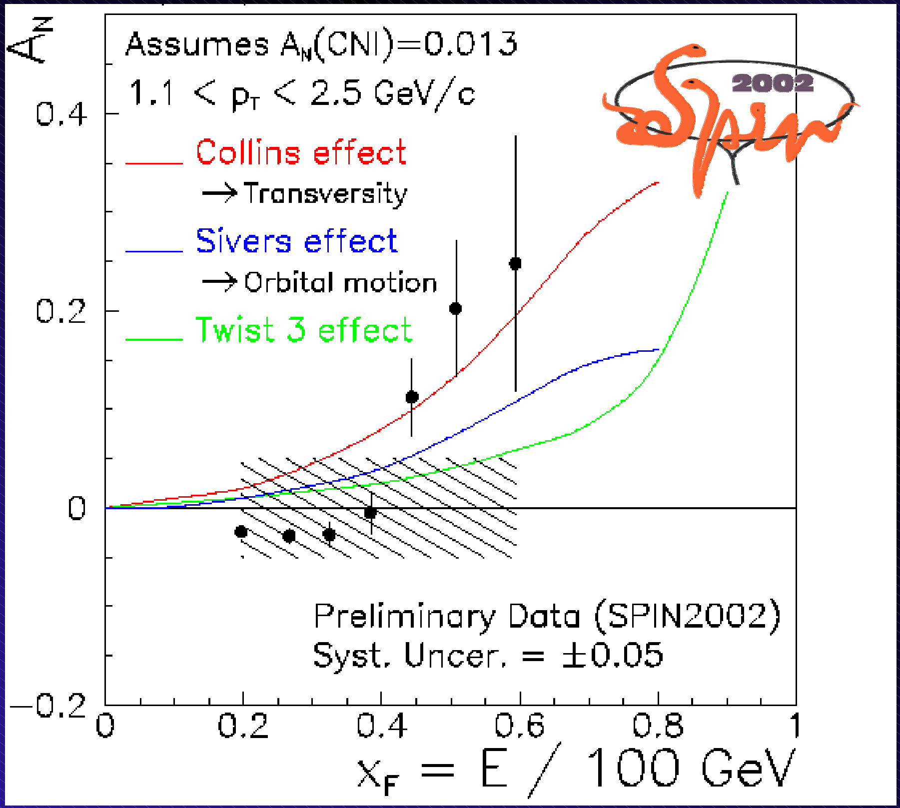


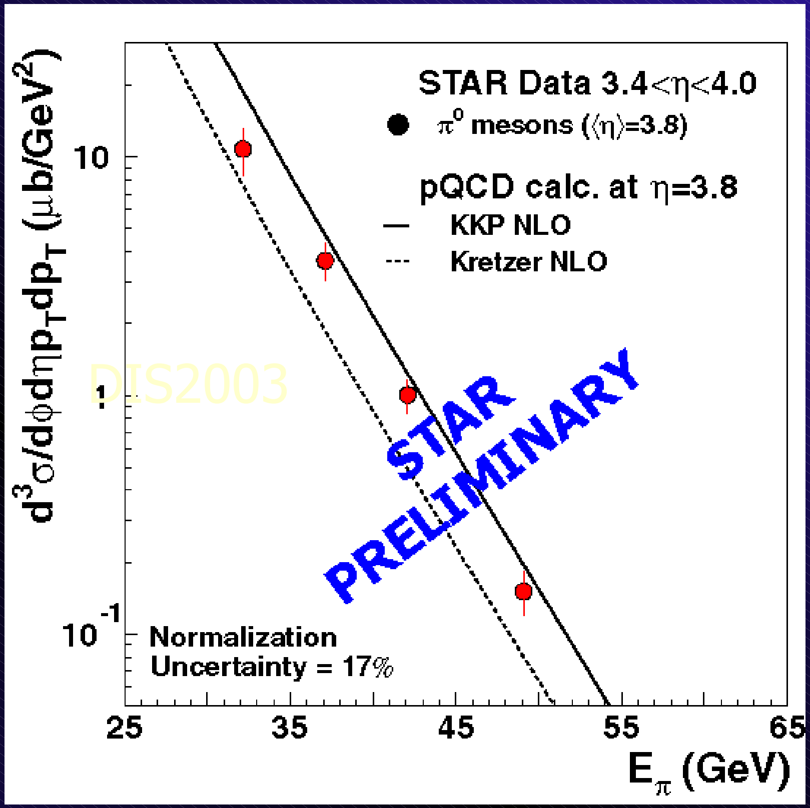
Run 3 Objectives:

- Probe of Color Glass Condensate in d+Au
  ⇒ p_T dependence of large η yield
- Improve understanding of dynamical origin of A_N in $p_\uparrow$+p → π^0+X ⇒
  - Collins effect → sensitivity to transversity
  - Sivers effect → sensitivity to orbital motion
  - twist-3 effect → quark/gluon correlations
- Serve as local polarimeter at STAR IR

STAR-Spin Results from Run 2

$$p_{\uparrow} + p \rightarrow \pi^0 + X, \sqrt{s} = 200 \text{ GeV}$$





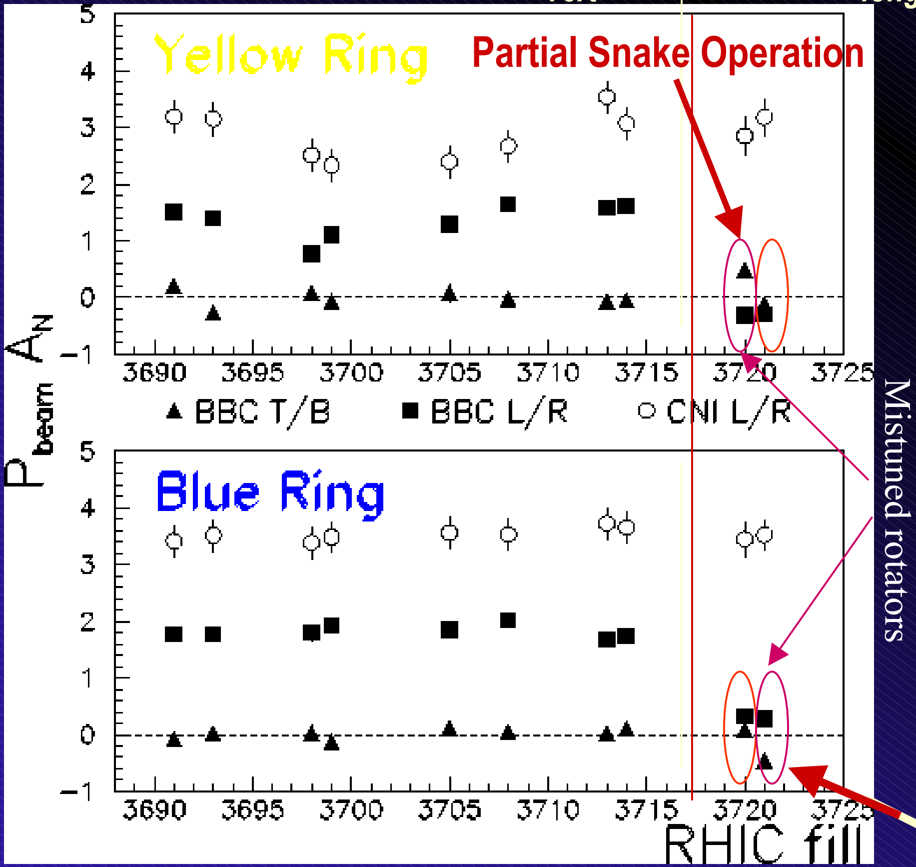
- Measured cross sections consistent with pQCD calculations
- Large spin effects observed for $\sqrt{s}$ = 200 GeV *pp* collisions

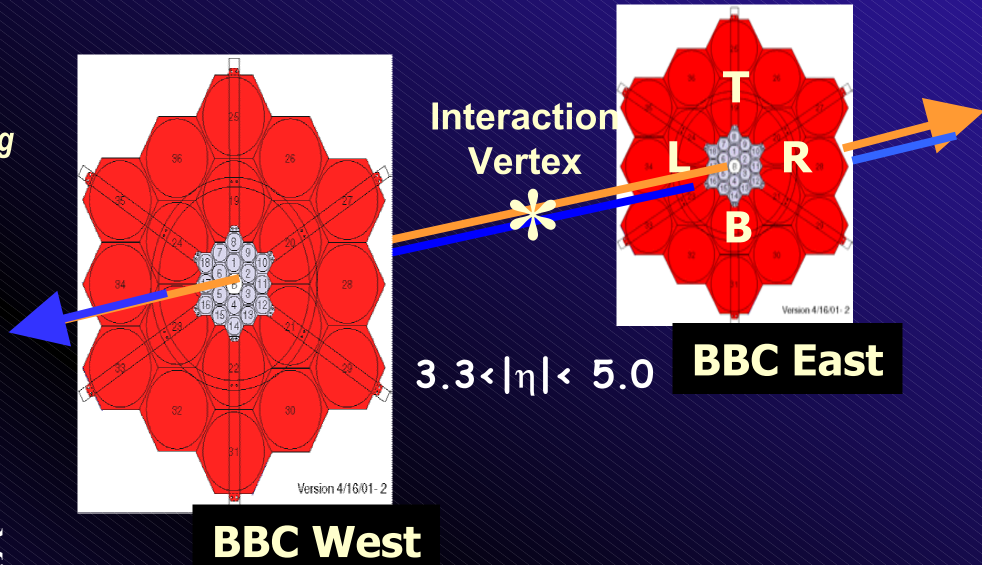
Status: final analysis complete / paper in final preparation

STAR Spin Rotator Magnet Tuning (Run III result)

RHIC polarimeter (CNI) establishes polarization *magnitude;*
Local polarimeter (BBC) establishes polarization *direction* at STAR.

STAR spin rotator: OFF ← $\Rightarrow P_{vert}$ | ON → $\Rightarrow P_{long}$



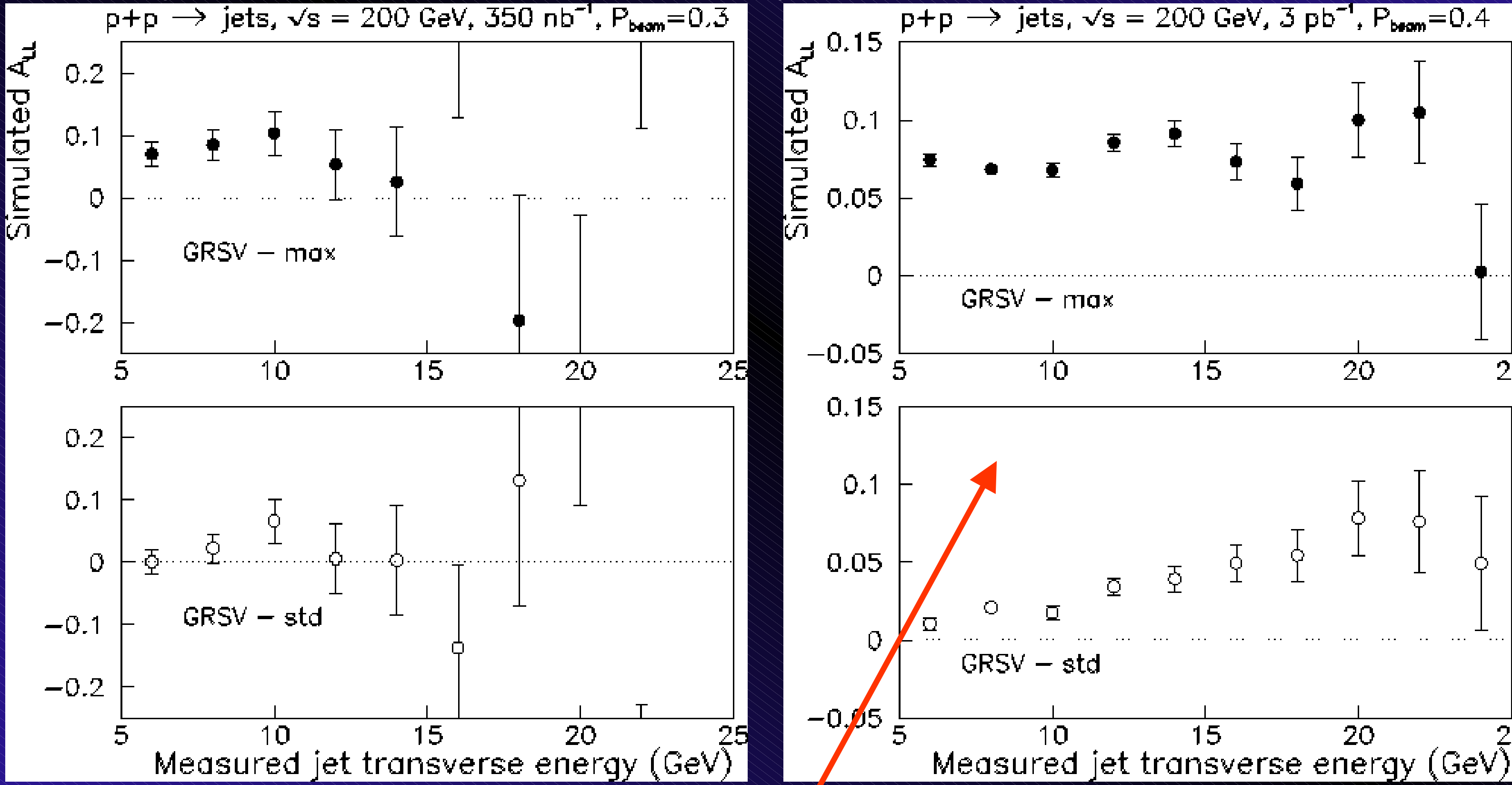


- Use inner tiles of BBC as a *Local Polarimeter* monitoring *pp* collisions.
- Rotators OFF $\Rightarrow$ BBC L/R spin asymmetries comparable to RHIC polarimeter (CNI).
- Rotators ON $\Rightarrow$ adjust rotator currents to minimize BBC L/R and T/B spin asymmetries.

"Double-blind" intentional mis-tune check

Projections for Sensitivity to ΔG for Run III and Run IV

Longitudinal spin asymmetry (A_{LL}) for mid-rapidity jet production
$\Rightarrow$ may be first measurements directly sensitive to gluon polarization.



Simulation based on Pythia + trigger and jet reconstruction efficiency
EMC Barrel Coverage includes $0 < \Phi < 2\pi$ and $0 < \eta < 1$
Jet Trigger: $E_T > 5$ GeV over one patch ($\Delta\eta = 1$) X ($\Delta\Phi = 1$)

Jet reconstruction: cone algorithm (seed = 1 GeV, R = 0.7)

Polarization 0.4, Luminosity: 3 pb^{-1}

STAR Spin Physics at RHIC:

Successful second run overall:

Spin Physics Measurement Goals from Run 3 BUR:

- **Measurement of the analyzing power A_N for neutral pions produced at large Feynman x and moderate transverse momentum.** ✓
- **Establish a robust means to commissioning and tune the spin rotators.**✓
- **Study transverse single spin effects for high-pt particle production at mid rapidity.**✓
- **Establish the level of the systematics for a first measurement of ΔG in $p\uparrow + p\uparrow$ if sufficient precision can be achieved and a significant non-zero A_{LL} is observed — data being analyzed.**

- **Even though these are early days, there are already exciting results**
- **There is clearly work to do (and a lot of work ongoing)**
  - Within STAR there is a focused set of world leading spin studies planned for the near term as well as for the longer term
- **The machine performance needed is not in hand and the constant effort scenario being discussed <u>(27 weeks) will not get us there</u>. The continued lack of a scenario that will is a <u>major</u> concern for STAR**

STAR Spin Physics Goals

Spin Physics Goals: Run IV:

Machine development / commissioning goals:
- Test effectiveness of NEG coated beam pipe
- Commissioning of polarized gas jet target
- Commissioning of warm-bore helical dipole
- Commissioning of RHIC AC dipole
- Establish new RHIC working point (WP) (2 IR's ?)

5 weeks

Physics Development Goals:
- Testing of RHIC working point
- First calibration of gas-jet target
- Statistics for A_{LL} in mid-rapidity jet production
- (Figure Of Merit = 5-10 x Run III) (If +2 , FOM = 20 x Run III)

+3 weeks

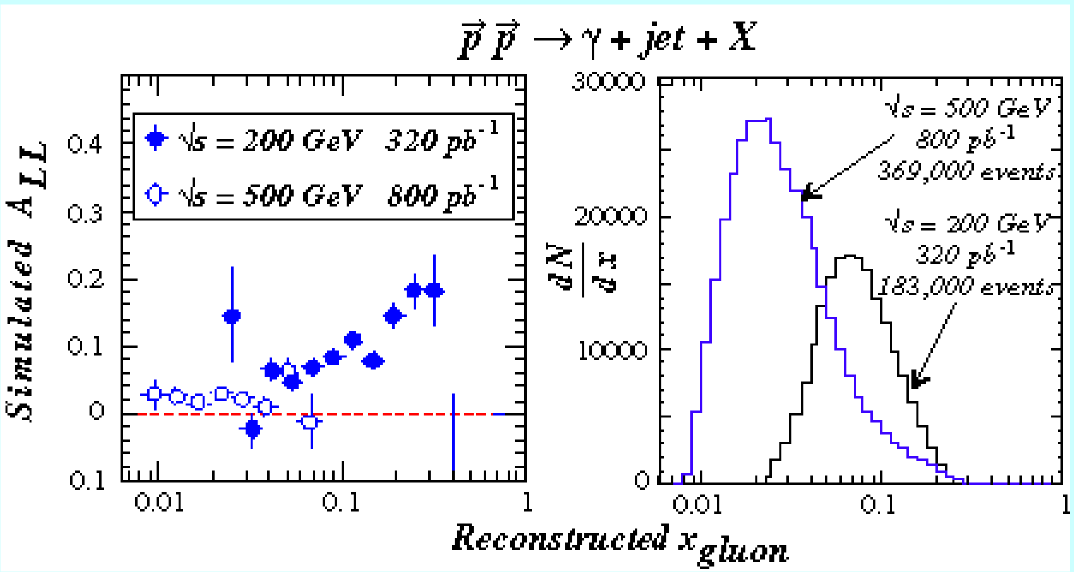
Spin Physics Goals: Run V

- Machine development / commissioning goals
- Luminosity development 2 x 10^{11} per bunch (versus 0.7 x 10^{11} ;FOM $\uparrow$ by 8.2)
- Commission cold bore helical dipole ($P \rightarrow 70\%$)
- Complete calibration of gas-jet target

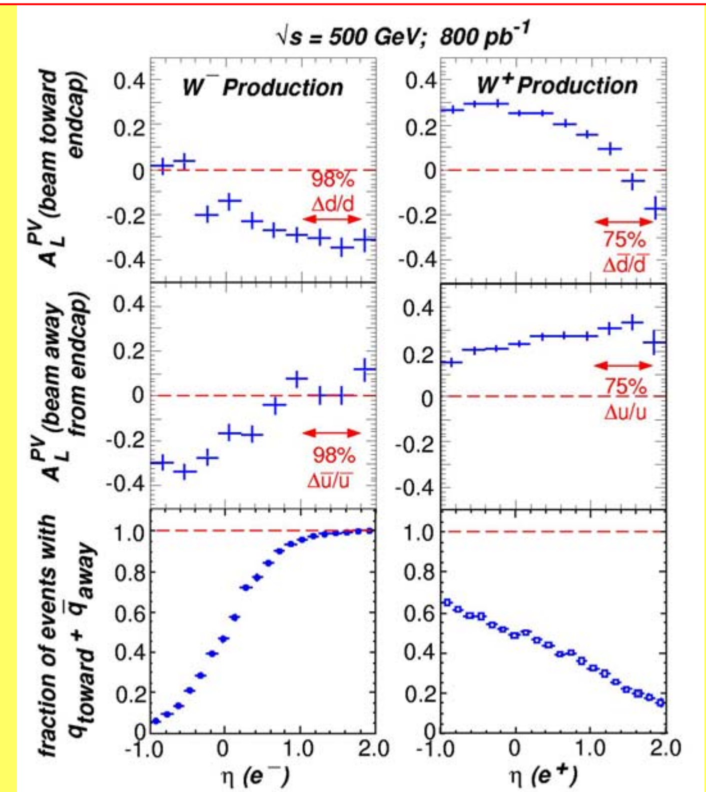
Physics Development Goals
- Transverse spin studies: forward π° vs x_F and p_T;
- Forward π° + forward jet (Collins angle);
- Particle correlations in mid rapidity jet production.
- If + 2 weeks, luminosity growth; $\rightarrow \gamma$ + jet studies

Future STAR Spin Physics Goals

$\Delta G\,(x)$ *determination via* A_{LL} *in*
$\vec{p} + \vec{p} \rightarrow \gamma + jet + X$



Δu *,* Δd *determination via* A_L^{PV} *in*
$p + p \rightarrow W^{\pm} + X$ @ $\sqrt{s} = 500$ GeV



At design luminosity, a 10-week runs (with ≈ 50% RHIC•STAR efficiency) apiece would yield:

- $\sqrt{s} = 200$ GeV, $P = 0.7$, $L = 8 \times 10^{31} \Rightarrow P^4 \int L \bullet eff\, dt \approx 60\ pb^{-1}$
- $\sqrt{s} = 500$ GeV, $P = 0.7$, $L = 2 \times 10^{32} \Rightarrow P^4 \int L \bullet eff\, dt \approx 150\ pb^{-1}$

Projected RHIC Au-Au luminosities

Fiscal year	2002A	2004E	2005E	2006E	2007E	2008E
No of bunches …	55	56	70	80	90	112
Ions/bunch, initial 109	0.7	0.9	1.0	1.0	1.0	1.0
Average beam current/ring mA	38	49	69	79	89	114
β^* m	1	1	1	1	1	1
Peak luminosity 1026 cm-2s-	15	12	19	21	24	32
Average store luminosity 1026 cm-2s- 1	1.5	2.9	4.7	5.3	6.0	8.0
Time in store %	25	40	45	50	55	60
Maximum luminosity/week (mb)-1	25	70	127	161	199	290
Minimum luminosity/week (mb)-1		25	25	25	25	25
Maximum integrated luminosity (mb)-1	89	580	1050	1340	1660	2410
Minimum integrated luminosity (mb)-1		210	210	210	210	210

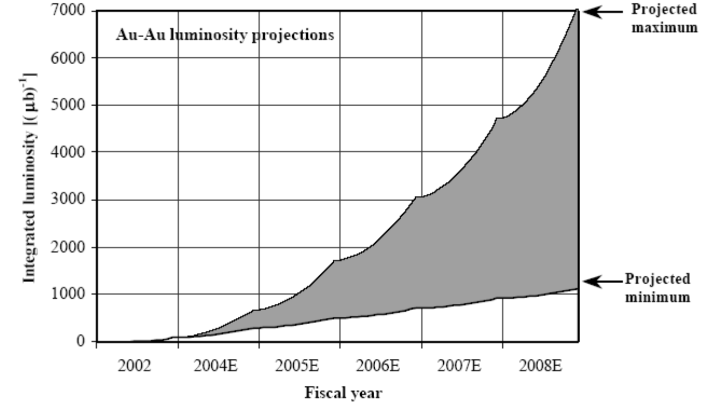


Figure 3: Minimum and maximum projected integrated luminosity for Au-Au collisions.

Running periods of 5 + 14 weeks required to meet projected luminosity targets !

Projected RHIC p-p luminosities

Fiscal year	2002A	2003A	2004E	2005E	2006E	2007E	2008E
No of bunches …	55	55	56	56	56	90	112
Ions/bunch, initial 1011	0.7	0.7	1.0	1.4	2.0	2.0	2.0
Average beam current/ring mA	48	48	70	98	140	225	280
β^* m	3	1	1	1	1	1	1
Peak luminosity 1030 cm-2s-1	2	6	11	22	45	72	89
Average store luminosity 1030 cm-2s-1	1.5	3	6	13	32	57	72
Time in store … 30 41 40 45 50 55 60							
Maximum luminosity/week (pb)-1	0.2	0.6	1.4	3.5	10	19	26
Minimum luminosity/week (pb)-1			0.6	0.6	0.6	0.6	0.6
Maximum integrated luminosity (pb)-1	0.5	1.6	12	30	84	165	224
Minimum integrated luminosity (pb)-1			5	5	5	5	5
AGS polarization at extraction %	35	45	55	65	75	80	80
RHIC store polarization, peak %	25	35	45	60	70	75	75
RHIC store polarization, average %	15	30	40	55	65	70	70

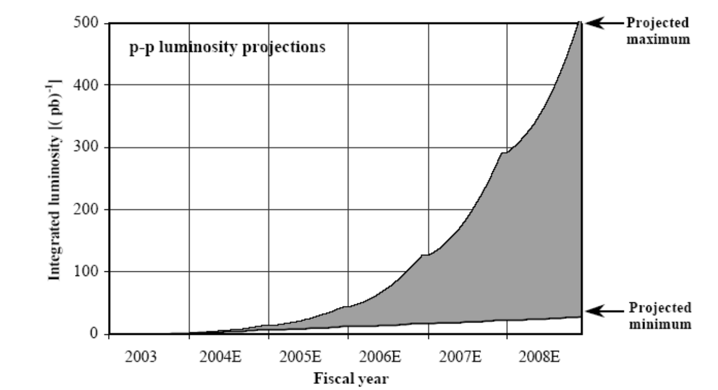


Figure 4: Minimum and maximum projected integrated luminosity for p-p collisions.

Running periods of 5 + 14 weeks required to meet projected luminosity targets !

STAR Spin Physics Goals

One Conclusion:

There is a lot to do!

Pretty clearly from STAR's view, for at least the next 2-3 years there will need to be spin running each year (as opposed to alternating years) to make steady progress

If that is folded with the fact that the heavy ion program also needs running time, it is not possible in a 27 week scenario to have long periods of running to develop the luminosity needed (~ 10-20 pb^{-1} / week in the case of spin)

A standalone running period of 27 weeks per year does not work !

A different solution – not yet in hand – is required

This is a problem for the program overall—not just for spin

STAR Multi-Year BUP Summary

Table XII

Run/Weeks	Mode 1/Weeks	Mode 2/Weeks	Mode 3/weeks	Mode 4/weeks	Mode 5/Weeks
Run IV, 27	AuAu @ 200, 5+14	p+p @ 200, 5			
Run IV, 37	AuAu @ 200, 5+14	AuAu @ 20, 1	AuAu @ 63, 4	p+p @ 200, 5+5	
Run V, 27	AuAu @ 20, 2	AuAu @ 40, 3	AuAu @ 63, 5 + 4	p+p @ 200, 5+5	or
Run V, 27	Cu-Cu @ 200, 5+9	p+p @ 200, 5+5			
Run V, 37	AuAu @ 63, 5+4	AuAu @ 20, 1	AuAu @ 40, 1	Cu-Cu @ 200, 5+6	p+p@200, 5+7
Run VI, 27	d+Au @ 200, 5+9	p+p@200, 5+5			
Run VI, 37	d+Au @ 200, 5+8	Cu-Cu@200,5+4	p+p@200, 5+7	or	
Run VI, 37	d+Au@ 200, 5+12	p+p@200, 5+12			
Run VII, 27	AuAu@200, 5+5	p+p@200, 5+9			
Run VII, 37	AuAu@200, 5+8	CaCa@200,5+4	p+p@200, 5+10		
Run VIII, 27	AuAu@200, 5+10	p+p@500, 5+5			
Run VIII, 37	AuAu@200, 5+14	p+p@500, 5+10			

Cu-Cu is a change from original request for Fe-Fe; Cu-Cu is requested for Run V or Run VI (not both)

C-AD indicates this combination (more than 2 modes/run) not possible with existing level of staffing

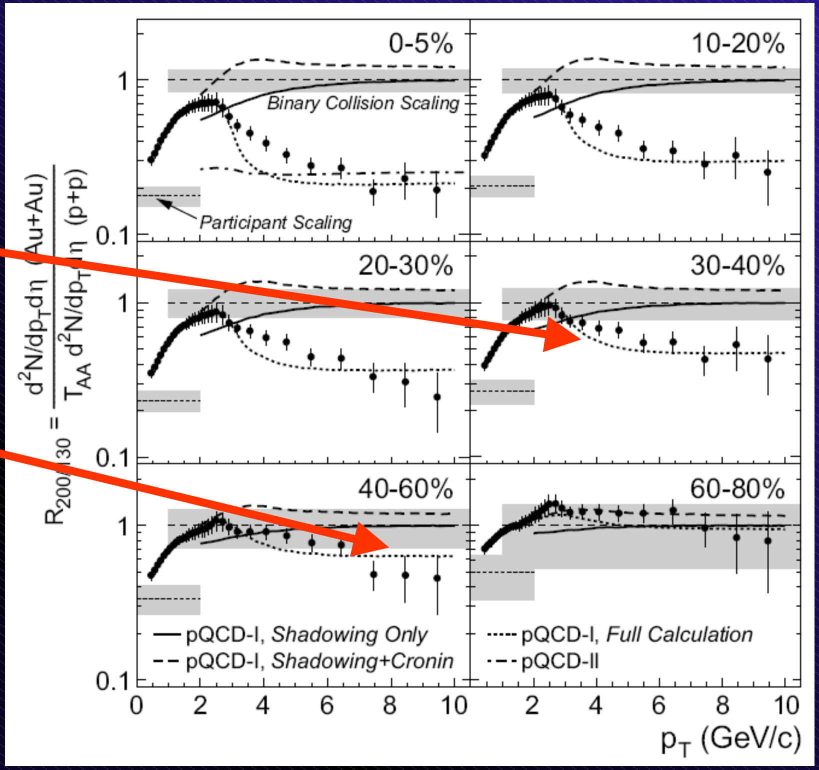
"Features": Periods of running for both heavy ions and spin physics each year;
Energy scan or species change for ions in Run V; Cu if different species;
Utilization of the full power of RHIC for comparison of different systems.

STAR Beam Use Proposal for Run V: Choice of Species

With respect to centrality:

For Cu, $N_{part} \sim 2A \approx 128 \Rightarrow$ expect at high p_T
$R_{AA} \approx 0.5$ for 30 - 40% where $N_{part} \sim 115$

For Si, $N_{part} \approx 56 \Rightarrow$ expect at high p_T
$R_{AA} \approx 0.8$ for 40 - 60% where $N_{part} \sim 62$
(with large uncertainty)



From Theory (Gyulassy CIPANP):

$$\Delta E_{GLV} \propto \frac{R}{\pi R^2}\frac{dN_g}{dy} \propto N_{part}^{2/3}$$

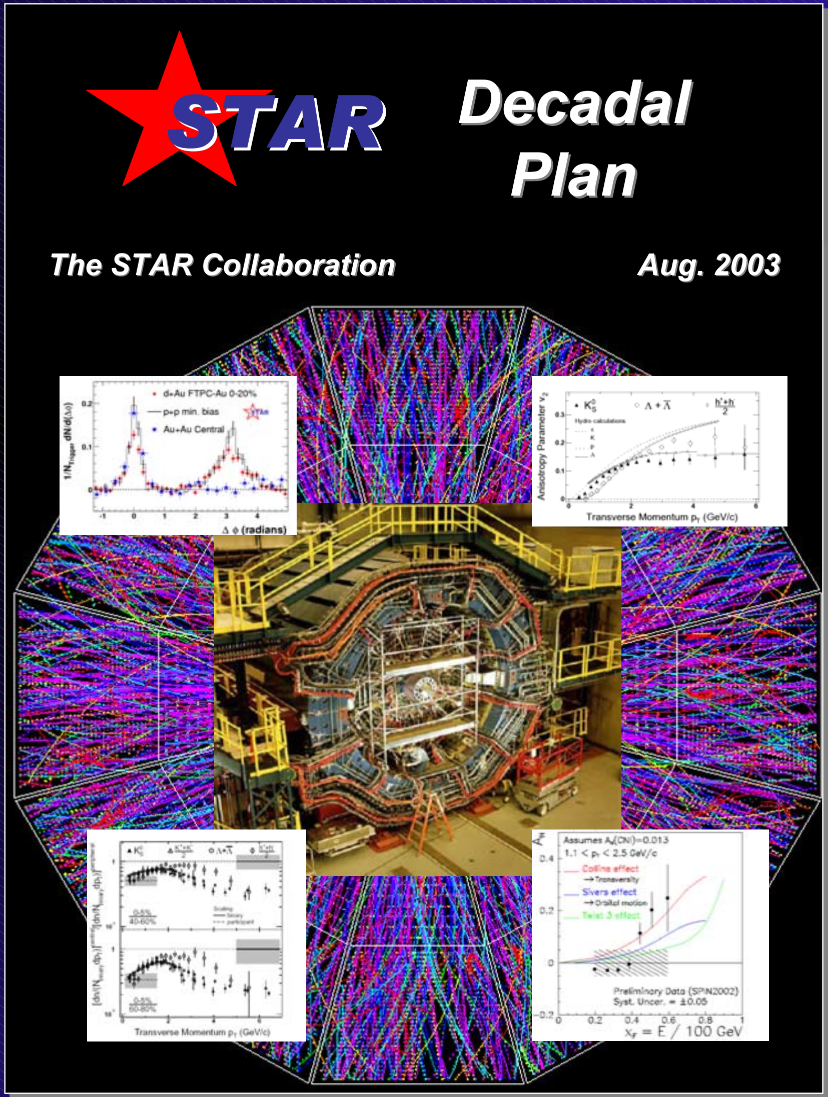
$Cu^{2/3} / Au^{2/3} \approx 0.5$
$Si^{2/3} / Au^{2/3} \approx 0.3$

$\Rightarrow$ Suppression expected for Si ~ 20-30%
Systematic on Normalization ~ 17%

Preferred species for STAR is Cu

Creating a Roadmap for STAR's Future

In response to solicitation by Tom Kirk last February:



- ***Decadal Plan Submitted to BNL September 2, 2003***

- ***Main elements: the physics and detector upgrades that drives the future program of STAR : a beginning roadmap.***

STAR Future Physics and Planned Upgrades

In the heavy ion program, to test and extend QCD theory and its predictions regarding the behavior of bulk color-deconfined matter, STAR will:

- use hard probes such as
  - Inclusive jets and direct photons
  - back to back jets (correlation of leading particles)
  - direct gamma + leading hadron from jet
  - flavor tagged jets
  - measurement of spectra and yields for the Upsilon family of states

  to measure the differential energy loss for gluon, light quark, and heavy quark probes which couple differently to the medium

- measure very large samples of “soft physics” events to unfold the bulk properties of the produced matter, studying e.g.
  - heavy quark thermalization
  - heavy baryon / meson elliptic flow
  - spectrum of extended hadronic matter (resonances)
  - broken / restored symmetries (e.g., cp violation, chiral restoration)

Some Main Themes of STAR Future Physics and Upgrades

- Measurement of the gluon density of the plasma using direct-photon tagged jets
- Flavor tagged jets to test perturbative QCD predictions of the quark mass dependence of partonic energy loss
- Spectra and yields for the Upsilon family of states to place significant constraints on the temperature
- Studying partonic collectivity by measuring bulk physics properties (e.g. spectra, elliptic flow, particle ratios, non-identical particle correlations) for particles and resonances containing light, strange, and charmed quarks
- Unfolding of large and small scale fluctuations and correlations for identified particles to map dynamics/evolution of the matter
- studying the effects of chiral symmetry restoration via leptonic decays of hadronic resonances in-medium
- Direct photon spectra via gamma-gamma HBT to provide information on the temperature and lifetime of the ear time partonic and later stage hadronic phases using a penetrating probe
- Search for new phenomena in bulk QCD matter such as strong CP violation
- Proton-nucleus studies to measure gluon densities at low momentum fraction to probe the effect of the nuclear medium on parton densities and determine initial conditions for nucleus-nucleus collisions
- Spin physics measurements to study the spin structure of the proton: the contribution to the proton spin from gluons using direct photon + jet, inclusive jets and di-jet production at moderately high pT (<5 GeV/c)
- The flavor-dependence (vs.) of the sea quark polarization using parity-violating W production and decay
- Studies of the effects of quark mass terms in the QCD Lagrangian
- Quark transverse spin preferences in a transversely polarized proton

The Collaboration is "fully engaged" by the future of STAR/RHIC and is moving to proposal prep

To carry out its future program STAR needs:

• A Barrel MRPC TOF	4 vector information for an additional 60% of the hadrons in final state; extended scientific reach for key observables
• A micro-vertex detector	precise (3 μm) hit position close to the primary vtx $\rightarrow$ D’s ,flavor- tagged jets
• A DAQ/ TPC FEE Upgrade	new architecture / FEE $\rightarrow$ 1 khz of events sampled at L3; effective integration of 10 x more data
• Development of GEM tech.	Preparation for a compact, fast, next generation TPC needed for 40 x L
• Forward Tracking Upgrade	W charge sign identification
• High Luminosity	10 - 50 times the luminosity (10 nb^{-1}) integrated at RHIC up to 2010 (Thomas Roser will provide)

STAR Future Physics and Planned Upgrades

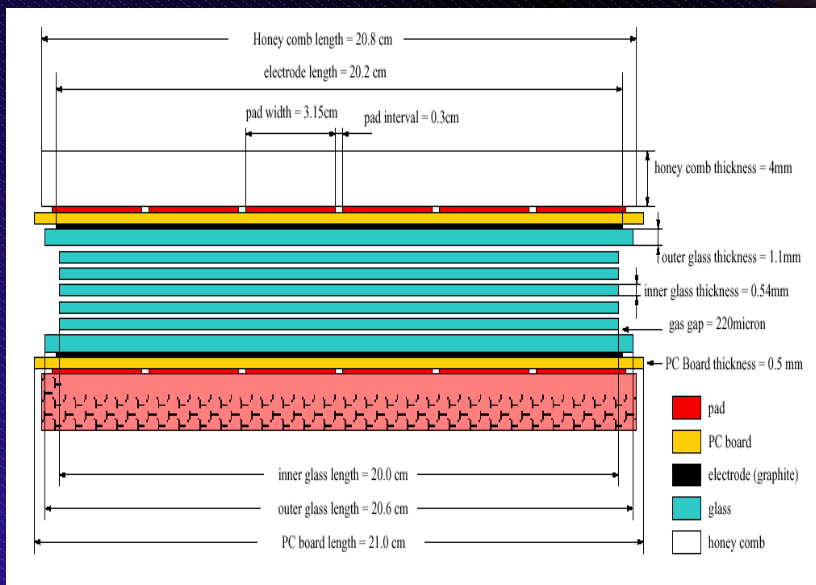
The Scope & Scientific Merit of Proposed R&D / Upgrade Plan

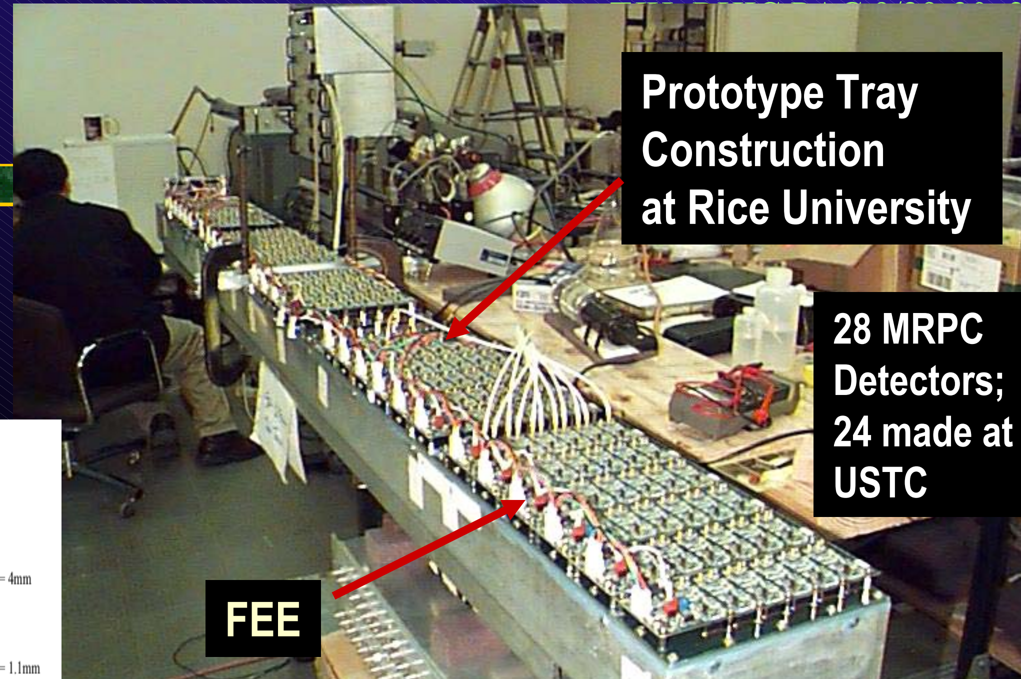
System	R&D	Constr/Cost	Benefit to STAR
Inner μvtx (Forward Tracker)	'04 → '06 $ 965K	' 06 → '07 $4M (TBD)	D's , flavor- tagged jets (Charge sign for $W^{\pm}$)
DAQ Upgrade	'04 → '06 $1.77M	' 06 → '08 $5M	1 kz → L3; D's; Ω & D, v_2, cp, D thermalization
FEE Upgrade	'04 → '05 $250k	' 05 → '06 $2.5M	1 kz → L3; D's; Ω, D, v_2, cp, D thermalization
Barrel MRPC TOF	' 04 → '05 $260k	' 05 → '06 $4.5M + $2.5M in- kind	4 vector information for all charged hadrons; extended p_T for resonances Ω v_2; D's; ebe correlations; anti-nuclei
GEM DeV	' 04 → '06 $900k	'08 - '10 ?	Compact, fast TPC;robust tracking for high Q^2 physics at 40 x L

To avoid seriously impacting the future of RHIC II, R&D must begin now

The STAR Barrel TOF MRPC Prototype

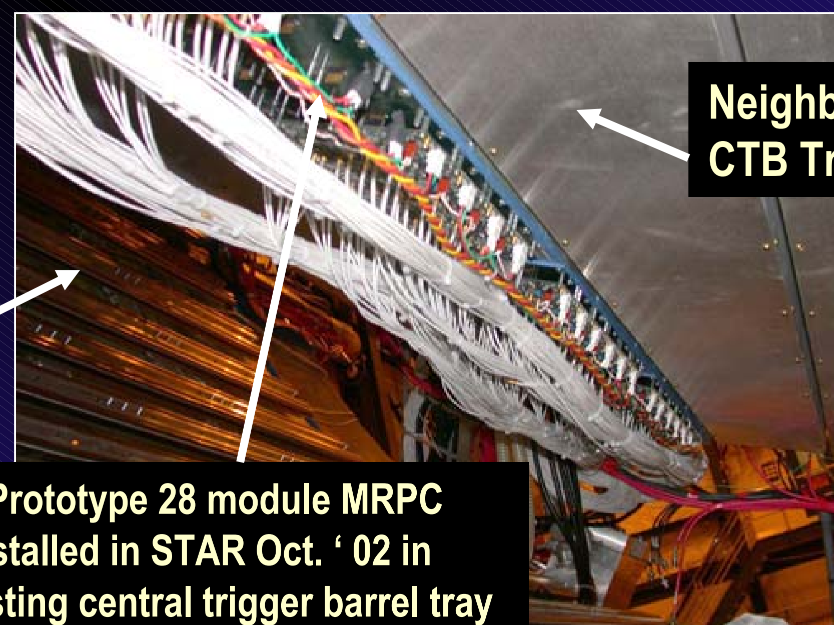
MRPC design developed at CERN, built in China





$\sigma \sim$ 50 ps, 2 meter path

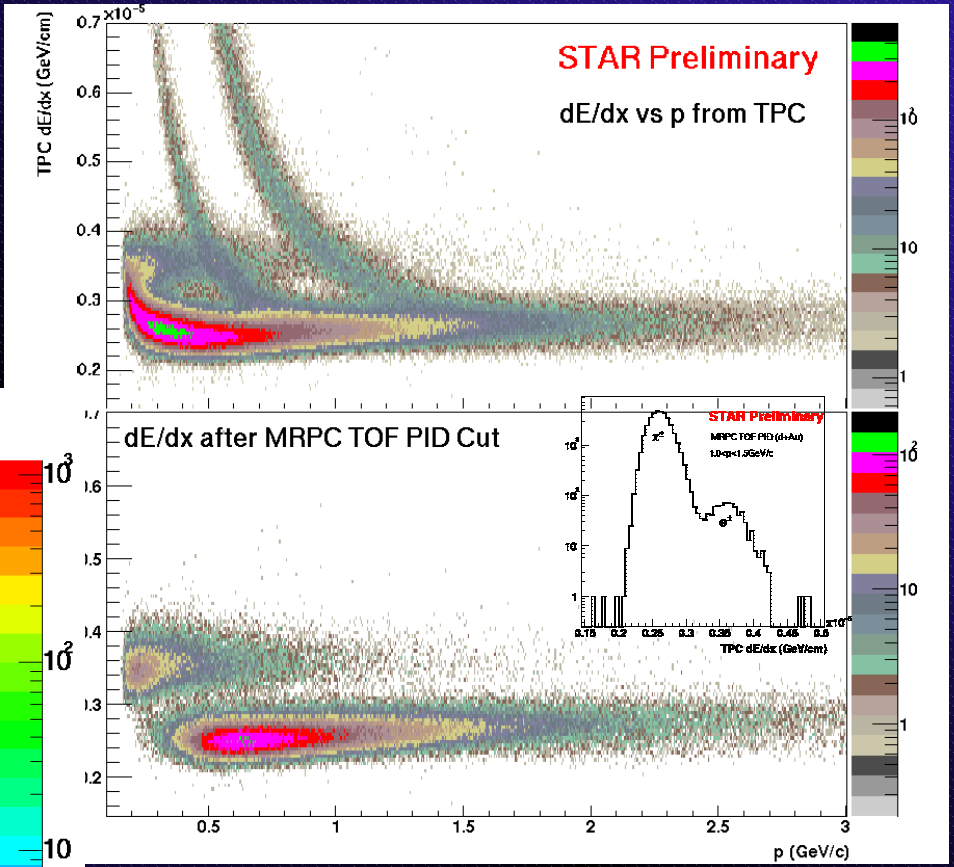
Strong team including 6 Chinese Institutions in place

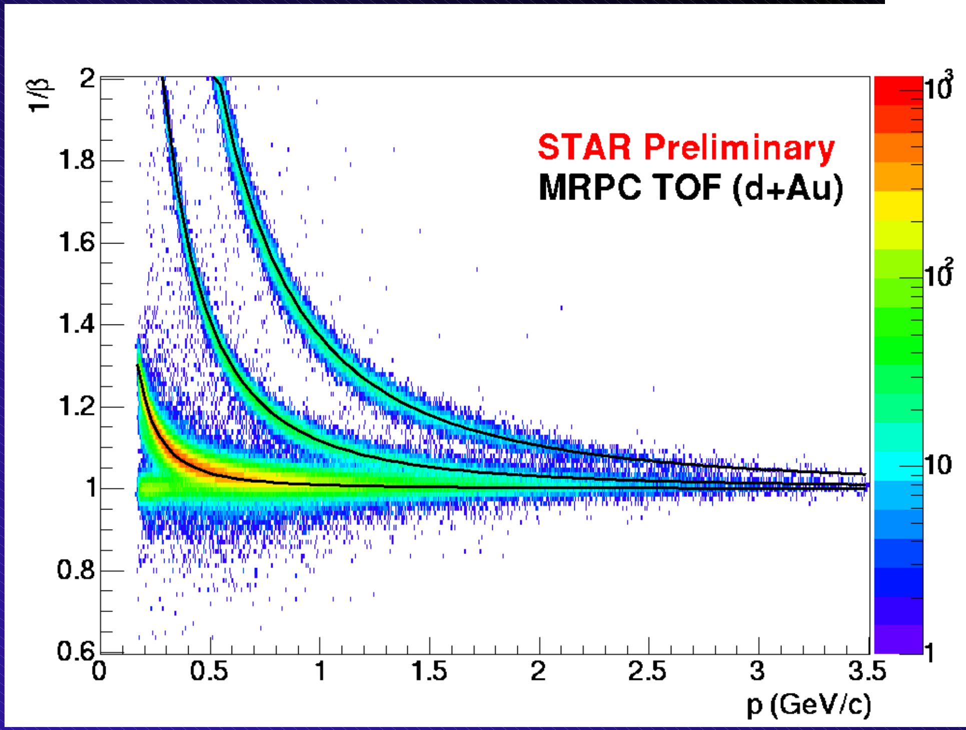


Completed Prototype 28 module MRPC TOF Tray installed in STAR Oct. ' 02 in place of existing central trigger barrel tray

The STAR Barrel TOF MRPC Prototype

Prototype modules met all performance specs in the STAR environment and produced important physics on PID'd Cronin Effect





Proposal reviewed and approved by STAR and submitted to BNL Management

STAR Multi-Year BUP - Conclusions

- The first 3 runs in STAR have been an outstanding success producing a wealth of results and new physics; even so, the most important achievements are still goals. The next 1-2 years will be extremely exciting.
- The highest priority scientifically for the coming run is to go as far as possible to determine the properties of the qualitatively new, dissipative medium discovered in central Au+Au collisions at RHIC, and to study how these may change at a lower energy.
- Continued progress on the RHIC spin physics program in the near-term is critical. A realistic plan which accomplishes sustained progress and allows sufficient running time to develop luminosity even in a constant effort scenario must be developed. Provided adequate machine performance, STAR strongly requests an additional 3 weeks in Run IV to increase statistics for A_{LL} in mid-rapidity jet production.
- STAR is now on a path to RHIC II. The strategy is to extend the scientific reach of the detector, maintaining the core capability of STAR to provide nearly complete event characterization over a wide range of central rapidity. Upgrades will be staged in such a way as to allow a vigorous physics program between now and 2010. R&D funding this fiscal year to get started in earnest is critical

Impact of STAR program

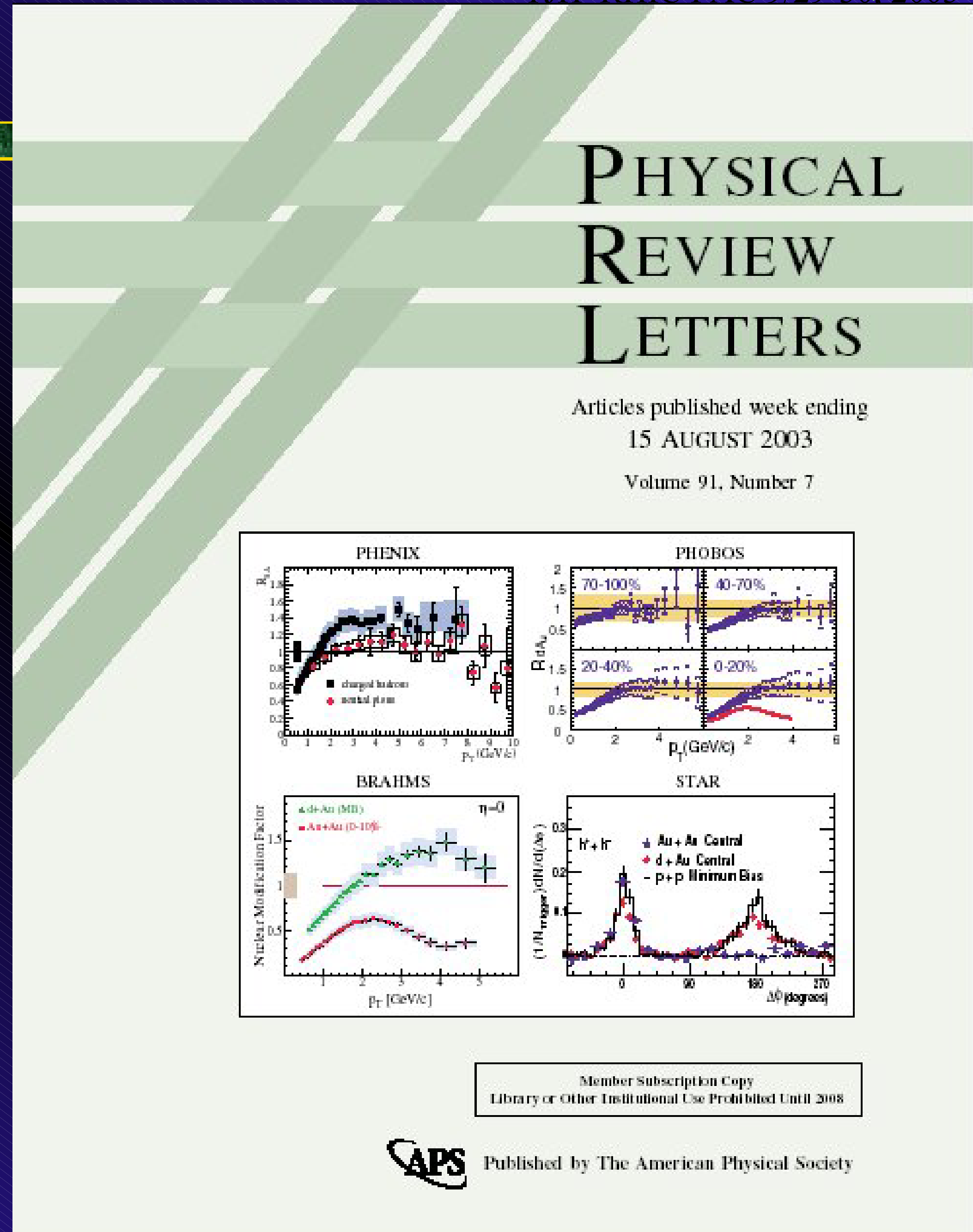
23 papers published or submitted since last PAC meeting

758 Citations as of July

23 Ph.D's granted as of July

75 Talks since last PAC

PRL Cover Article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